

Open Research Online

The Open University's repository of research publications
and other research outputs

The multimedia brain

Journal Item

How to cite:

Hall, Marion and Robinson, David (1995). The multimedia brain. *Active Learning*, 3 pp. 36–41.

For guidance on citations see [FAQs](#).

© 1995 CTISS Publications

Version: Accepted Manuscript

Copyright and Moral Rights for the articles on this site are retained by the individual authors and/or other copyright owners. For more information on Open Research Online's data [policy](#) on reuse of materials please consult the policies page.

oro.open.ac.uk

The Multimedia Brain

Marion Hall & David Robinson

Biology Department, Open University, Milton Keynes, MK7 6AA, UK

Fax: 01908-654167

Telephone: Marion Hall: 01908-655136; David Robinson: 01908-653493

E-mail: M.J.Hall@open.ac.uk and D.J.Robinson@open.ac.uk

Abstract

The Open University is producing an interactive multimedia tutorial on the brain and nervous system on CD-ROM, for use in its Biology: Brain and Behaviour course. Such a tutorial could have a wider use in higher education as the subject matter is known to be difficult for students to master. A prototype version has been produced. Consultation is now taking place before work starts on a fully functional version that can be evaluated for educational effectiveness.

Introduction

Students studying the second-level Open University course *Biology: Brain and Behaviour* spend a substantial amount of time studying the structure and function of the nervous system.— 7 of the 32 study weeks of the present 60 credit points course are, for example, spent on basic neurophysiology and the anatomy of the brain and spinal cord. Our experience is that a majority of the students find this part of the course very difficult and they take more time over studying it than we anticipated. This problem may well be a familiar one to staff in other institutions.

The course has been running in various incarnations since the early 1970s but there have always been problems with teaching this material successfully. In particular, the complex three-dimensional shape of the internal structures of the brain is extremely difficult to describe, making the anatomy of the brain both difficult to teach and difficult for students to understand. The difficulties are increased by the fact that students taking *Biology Brain and Behaviour* come from a wide range of backgrounds, many with no biological knowledge or experience whatsoever.

Earlier versions of the course relied on specially written texts and an audiotape which guided students around a plastic model of a human half-brain. The model is in three dimensions and comes to pieces to show internal structure, but only in a very limited way. Assessment results and feedback from students made it clear that these resources were not sufficient, especially to teach the anatomy of the brain. For example, results of a questionnaire sent out to students in 1989 (Figure 1) show that, on average, 80.5% of students found the section of the course that deals mainly with basic neurophysiology, anatomy and development of brain and spinal cord either 'very difficult' or 'fairly difficult' and only 19.5% found it 'not very difficult' or 'not at all difficult'. Far fewer students found either the previous section or the subsequent section of the course difficult (55% and 45% respectively). Students also spent more time studying the section on basic neurophysiology and anatomy and development of brain and spinal cord compared with either the previous section or the subsequent section.

Figure 1. Results of a 1989 survey of students taking Biology: Brain and Behaviour

Section of Course	Students who found it 'very difficult' or 'fairly difficult'	Students who found it 'not very difficult' or 'not at all difficult'	Students who spent more than the recommended 12 hours on each unit
neurophysiology/anatomy	80.5%	19.5%	60%
previous section to neurophysiology/anatomy section	55%	45%	20%
subsequent section to neurophysiology/anatomy section	64%	36%	34%

So, in 1990, when the *Biology Brain and Behaviour* course was remade from scratch, it was decided to produce a video of animated three-dimensional images of the brain, at the BBC Open University Production Centre. Animated sequences in the 50-minute video¹ show various parts of the brain being rotated to reveal their three-dimensional shape, and demonstrate how the various parts of the brain fit together. In addition to the video, *Biology Brain and Behaviour* continues to use the model of the brain, with a new version of the associated audiotape, and the course texts, now rewritten in textbook form, to teach the anatomy of the nervous system.

The *Human Brain* video is a considerable improvement on static, two-dimensional illustrations and text. A survey of students who took the new version of the course in its first year in 1992 revealed that 89% of them felt it helped them to understand brain anatomy and 84% of them felt it gave them a better understanding of the related course texts. 86% of students watched it more than three times. As a linear video, however, students find accessing particular sections both difficult and time-consuming, despite the presence of section and frame numbers. This limits the effectiveness of the video both as a teaching and as a reference resource and is a constraint on the way that we can integrate the anatomical information into the later parts of the course on function and dysfunction.

The variety of different media used to teach brain anatomy is necessary for a subject that is so demanding and so central to the course. However, it does make study more complicated and students find it difficult to refer back to information on structure at later stages in the course. Another problem is that function — the physiology of the nervous system, the nervous control of behaviour, etc — is taught separately from structure. As a result, students find it difficult to integrate the two. Again various media are used — course texts, broadcast TV, audiotapes, and video, plus computer-based tutorials that students study at a residential one-week Summer School.

These problems are not unique to the Open University. Traditional anatomy textbooks rely on photographs or drawings that use perspective to give the impression of three dimensions, but written descriptions and images on the printed page of sections through the brain do little to convey 3-dimensional information, particularly to the inexperienced. In discussions with educators in Biology and Medical Departments of other Universities, it has become apparent to us that they face similar difficulties to the Open University in teaching brain structure, even though they often have the advantage of being able to offer students practical experience of seeing and handling real brains, something which the Open University, as a distance-teaching organization, is largely unable to do. Furthermore, structure and function are often taught in separate undergraduate courses, which is likely to give conventionally-taught students the same problems as we find amongst Open University students.

We are developing an interactive, multimedia CD-ROM, provisionally called *The Multimedia Brain*, which we hope will improve student's understanding of the structure

and function of the human nervous system and reduce the excessive amounts of time that they need to devote to this section of the course. The aim is to integrate not only the teaching of structure and function but the different media — text, drawings, photographs, video, audio, and computer simulations — currently used to teach this difficult and complex subject.

Several interactive multimedia, computer-based resources for use in teaching brain anatomy and/or histology already exist, such as the three Neuroanatomy CD-ROMs produced by the Anatomy Project². These resources often make extensive use of high-quality stills (e.g. histological and anatomical sections), video (e.g. of actual dissections of human and animal brains) and animation. There are also numerous simulations of neurophysiological processes and experiments, such as Dewhurst's *Nerve Physiology*³, which provides a number of simple experiments that can be performed on the frog sciatic nerve preparation. We are not aware, however, of any resource that integrates structure and function or which uses high-quality, animated, three-dimensional images of individual parts of the human brain to teach anatomy, at the required level, as is planned for *The Multimedia Brain*.

The primary object in developing *The Multimedia Brain* is to serve our own students but it should be possible to produce a flexible package that is of general use in any Biology, Physiology or Medical Department. It is the potential for wider use outside the Open University that prompts this paper.

Materials

The CD-ROM will be based mainly on materials already in existence: most from *Biology: Brain and Behaviour*; others from elsewhere within the Open University and the BBC. The current course components are listed in Figure 2.

Figure 2. Components of the Biology: Brain and Behaviour course.

Study weeks	Course Texts	Associated TV programmes	Associated Video programmes	Associated audiotape sequences
1–6	Book 1: <i>Behaviour and Evolution</i>	2 (approaches to studying behaviour; animal conflict)	2 (analysing behaviour; behaviour of primates) plus 5 short sequences	1 (bird song)
7	<i>Guide to Designing Experiments</i>			
8–14	Book 2: <i>Neurobiology</i>		1 (<i>Human Brain</i>) plus 3 short sequences	3 (two revision tutorials; tape with model brain)
15–18	Book 3: <i>The Senses and Communication</i>	2 (processing sound; pain)		3 (animal sounds; human communication; pain)
19–22	Book 4: <i>Development and Flexibility</i>	1 (development of the nervous system)		1 (learning)
23–26	Book 5: <i>Control of Behaviour</i>	2 (stress; seasonal affective disorder)		
27–32	Book 6: <i>Degeneration, Damage and Disorder</i>	1 (autism)		1 (problems of mind and brain)

Biology: Brain and Behaviour was published electronically so all of the text is already in word-processed form. Text on screen will, however, be kept to a minimum: we feel that the best place for large amounts of text is still the printed page.

Images produced for the *Human Brain* video were generated by several methods by the Graphic Design Department of the BBC Open University Production Centre and the

Academic Computing Service of the Open University. A database of measurements of the human brain was used to generate some graphics sequences. We employed a brain anatomist for a year to set up the database and work with the programmers and graphic designers to produce the three-dimensional images. The television programmes and audiotapes listed in Table 2 were produced by the BBC especially for the course and these will provide a source for sound, video and stills for the CD-ROM. There are also TV programmes and audiotapes from other Open University courses from which material can be taken and, relevant segments from many television and radio programmes made by the BBC for general broadcasting could be used. In addition, we intend to originate new material, including commentary and further computer animations.

Methods

We intend to produce the CD-ROM using the 'Scholar's Desktop', a software 'shell' produced by the *Biodiversity Consortium*⁴, which is part of the Teaching and Learning Technology Programme (TLTP) funded by the Higher Education Funding Council. The Biology Department of the Open University is one of four lead departments in the *Biodiversity Consortium*, and our involvement has enabled us to produce a fully functional prototype (Figure 3) of the proposed *Multimedia Brain* CD-ROM based on Version 1.3 of the Scholar's Desktop. The prototype displays most of the features we hope will be available in the final CD-ROM and contains about 5% of the material we intend to cover, including 25 video clips, over 30 sound clips and more than 200 photos and graphics.

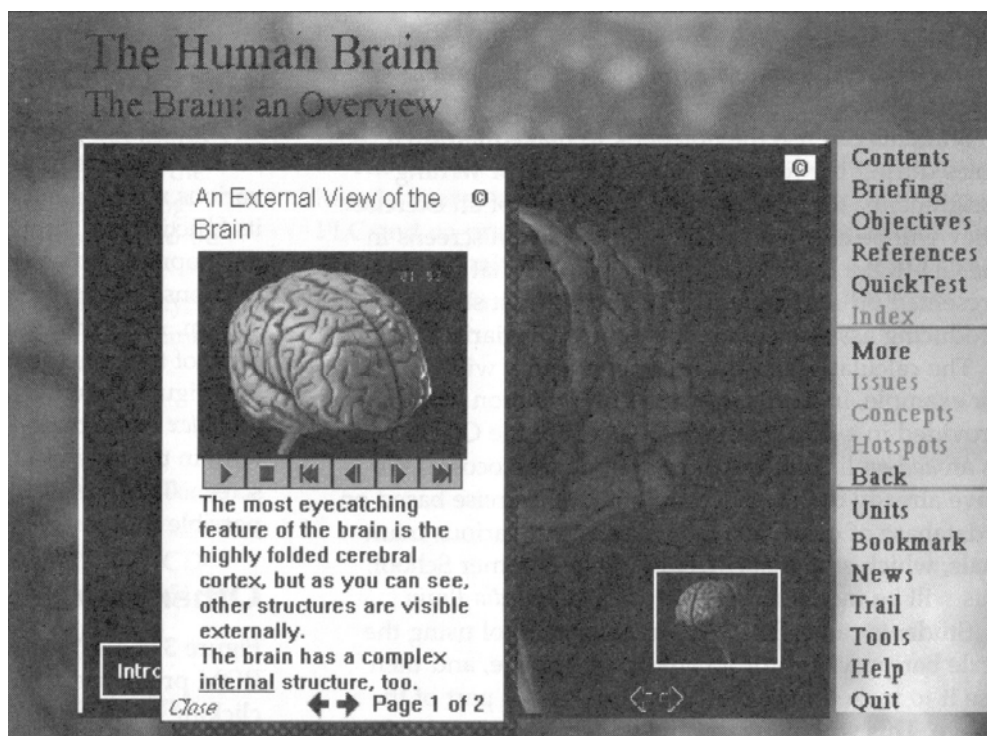


Figure 3. The first screen of the overview node of the prototype of The Multimedia Brain CD-ROM with a pop-up window showing a video rotation of the whole brain.

A feature of the Scholar's Desktop is that all the resource files are external to the programme and can be readily changed during development. It runs under Windows and other Windows applications such as Notepad and Calculator have been incorporated. To display the high quality graphics the programme requires at least 32K colours and at present runs best on a 486-33 PC or better. A new Version of the Scholar's Desktop currently under development will run faster and require a lower specification machine. A Macintosh version of the shell is being

produced by the consortium and we plan to produce a versions of the *The Multimedia Brain* for for the Macintosh as well as for the PC platform. A full version of the CD-ROM should be ready for alpha-testing by the end of 1996.

We plan to make extensive use of audio. It will be invaluable in sections on, for example, the sense of hearing and the control of speech but it will also be used to reinforce information presented as video or text. With hearing-impaired students in mind, however, we intend to make it possible to switch to on-screen subtitles instead of audio sequences or video commentary.

Pedagogical approach

The CD-ROM will provide students with an introduction to the structure and function of the human nervous system. It will provide both a structured tutorial to teach students about the nervous system and a reference resource. The aim is for students to work through *The Multimedia Brain* tutorial during weeks 8–14 of the course, in parallel with the *Neurobiology*⁵ course textbook. Thereafter, they will use the CD-ROM as a reference resource and can be directed to particular sections at later points in the course or can look up subjects for themselves. Materials currently in Books 3, 4 and 6 of the course (see Table 2), on the senses and pain; the development of the nervous system; and the effects of mental illness, damage, neural disease and ageing on the nervous system and behaviour, will also be incorporated into the *The Multimedia Brain*. In total, the CD-ROM should represent at least 30 hours of study time, or about 10% of the time required to study the whole course.

Until it has been fully evaluated, *The Multimedia Brain* will be an optional component of the course, replacing, for those students who wish study it, the *Human Brain* video, many of the short video sequences, and a substantial portion of the text. Eventually, the intention is to rewrite the relevant parts of the course around the CD-ROM.

There will be several ways to update and extend the materials in *The Multimedia Brain*, essential in a fast-moving subject area like neurophysiology. We will be able to modify the contents of the CD-ROM easily for new editions because of its shell-based structure. Educators will also be able to modify the tutorial. A *News* option (Figure 3) will allow them to add extra information, updates and commentaries at any time. We intend that Microcosm will also be available as a tool. This software⁶, developed at the University of Southampton, makes it possible to link into other applications without apparently leaving the CD-ROM. This will enable educators to update or extend the CD-ROM simply by ‘adding on’ documents of their own, such as databases or spreadsheets. Changing the add-ons will be possible at any time.

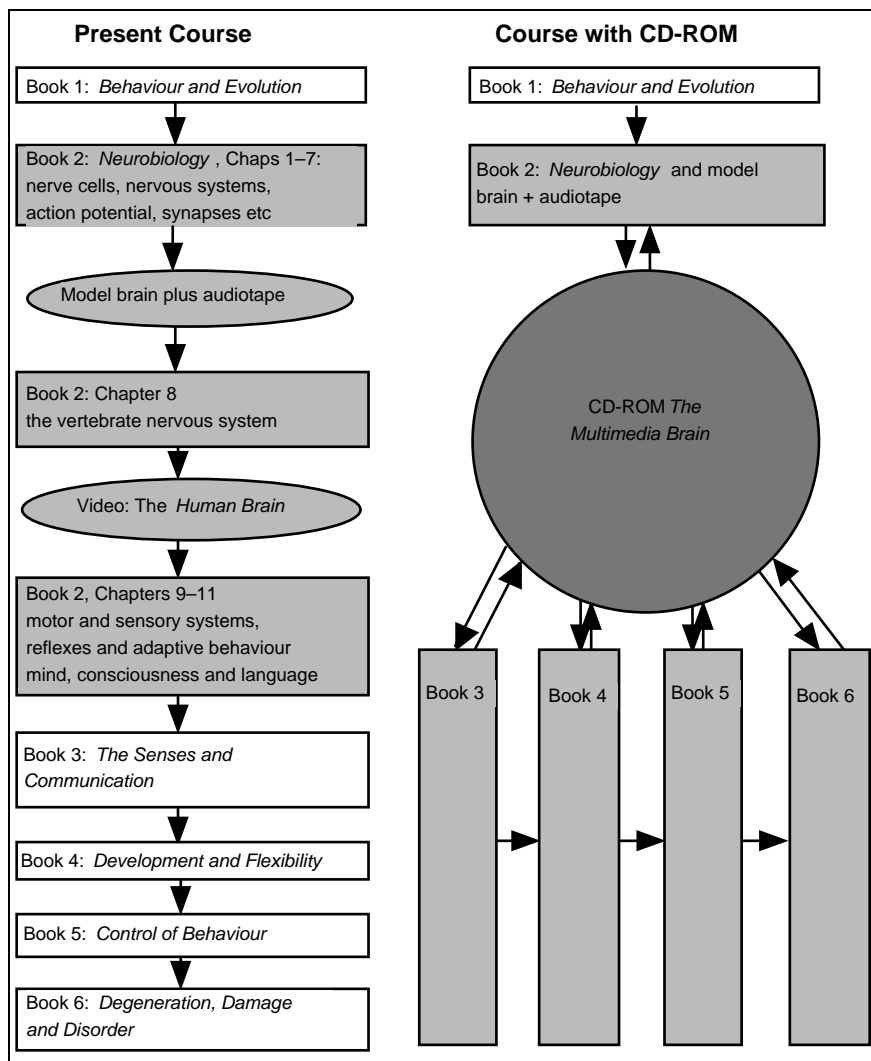


Figure 4. The place of *The Multimedia Brain* in the Biology: Brain and Behaviour course. The present course has a linear structure. Introduction of the CD-ROM will allow a much greater integration of course materials.

The CD-ROM as a teaching resource

Using the CD-ROM as a teaching resource, students will be guided through the available information in a way that will enable them to meet specific learning objectives, which they can refer to by choosing *Objectives* from the menu (Figure 3). They will also be provided with a series of checklists of e.g. parts of the brain that they have to study, so that they can make sure they cover everything that they need to.

The CD-ROM will be structured in a relatively linear way, with a limited number of hypertext links and only a few side paths available at each stage in the tutorial, each consisting of no more than three extra levels and leading to a 'dead-end' which forces the student to return to the main route. This means that students will have the opportunity to explore additional, more detailed, materials if they wish, but can always return easily to the main route. We see the ability to navigate easily through the material as a vital feature of the CD-ROM. If students are to meet defined learning objectives, it is important that they study all the relevant materials and do not simply wander around in a sea of information. One of the problems associated with 'encyclopedia'-style CD-ROMs is that the user can easily get lost in a succession of hypertext links and cannot find their way back to where they were.

One problem which all students of brain anatomy are likely to find difficult is the plethora of unfamiliar Latin names for the various parts of the brain. Open University students have an additional problem in that, as distance learners, they do not hear the names spoken so do not know how to pronounce them. *The Multimedia Brain* addresses the latter problem by using audio to provide guidance on pronunciation. Help in remembering the terminology is given by providing an explanation of the meaning of each name, associated in each case with a picture related to the meaning, which we hope will act as an *aide memoire*. Thus the explanation of the meaning of 'fornix', from the Latin for 'arch', is accompanied by a picture of Roman arches.

The Multimedia Brain will be highly interactive. As well as allowing students to control the pace at which they move through the material and providing hypertext links for them to use as they wish, the *Multimedia Brain* will be truly interactive in the sense used by Laurillard⁷. She defines interactivity as enabling students themselves to act to achieve the task goal; something will then "change in the 'system' as a consequence of the student's action"; and meaningful intrinsic feedback on the action will be provided that relates to the nature of the task goal. In *The Multimedia Brain*, students will be required to complete a number of interactive exercises. The prototype already includes several, including two, on visual illusions and visual receptive fields, that students currently study at Summer School as separate DOS-based computer tutorials.

As well as this ability to link into such DOS-based programmes, the Scholars' Desktop has a number of tools available which can be used in interactive exercises. Selecting *Tools* from the menu (Figure 3) provides students with access to, amongst other things, a notebook, a calculator, a graphing facility, and a measuring tool.

Students can use the notebook to make their own notes during the tutorial, in preparation for writing assignments, for later revision, or as part of an exercise. They will be able to cut and paste text from screens in the CD-ROM: the limited amount of text that will be presented on screen should militate against students producing assignments in an entirely plagiarized form!

The calculator and the graphing facility will be used, for example, in the analysis and presentation of data provided in a database, either as part of the CD-ROM or as an 'add-on' linked to the tutorial via Microcosm. We have already developed an interactive exercise based on a database of comparative brain sizes in various mammals, which students currently do at Summer School; this will be incorporated into *The Multimedia Brain*.

Students can calibrate the measuring tool using the scale bar provided for an anatomical image, and then use it to make linear measurements of any part of the image. This will allow us, and educators using the CD-ROM, to set up exercises in which students are required to make measurements of either the gross or microscopic structure of the nervous system; for example they might be asked to compare the size of a particular structure on each side of the brain.

The CD-ROM as a reference resource

Using the CD-ROM as a reference resource, students will be able to access quickly and easily information from various media about a particular part of the brain, explore its function and structure, and study its evolution, development, microscopic structure, pathology, and relationship with other parts of the brain and nervous system. Access in the prototype is achieved via a list of parts of the brain provided under the *More* menu item (Figure 3). In the next version, it will be achieved via an *Index* menu button — students will be able to click on a term in the index and be taken straight to the appropriate screen. The index will also contain a 'map' showing all the possible routes through the material.

Other Features of *The Multimedia Brain*

Figure 3 shows a number of other features of the CD-ROM prototype. The popup has been displayed by clicking on to a hotspot — the small brain in the box at the bottom right. The popup includes hypertext links, in the form of underlined words, to other relevant topics, and a video clip which the student can play, rewind, fast forward or go through frame by frame.

Selecting *QuickTest* from the menu generates a question, chosen at random from a bank of questions appropriate to the section the student is studying at the time. This allows the student to monitor their own progress. The student will be able to access questions at any point during the tutorial.

Selecting *Briefing* from the menu gives students guidance on how to study the tutorial and why the subject matter is relevant. As well as the tools already mentioned, *Tools* provides a glossary, which gives a definition of a term typed in by the student.

Evaluation

We believe that the *The Multimedia Brain* CD-ROM will provide a single coherent, but flexible, interactive teaching package that will greatly improve the learning process. However, to ensure that the CD-ROM does provide a better means of learning about the nervous system than conventional materials, we will be conducting a full evaluation of its usability and pedagogic effectiveness.

The Scholar's Desktop shell has already been formally evaluated for usability during its development as part of the *Biodiversity* project, with results from the evaluation study being fed back into the design process⁸.

A formative study will also be made of the overall usability of the *The Multimedia Brain* and a summative study of its effectiveness as a teaching tool. In the latter, we will compare the degree of knowledge acquisition (based on assessment results) between students studying the CD-ROM and students studying the relevant part of the existing *Biology Brain and Behaviour* course. Results of the evaluation will be fed back into the development process.

Current Work and Future Plans

There are several additional features that we are currently working on for inclusion in the next version of *The Multimedia Brain*. For example, we will be giving students the facility to control the rotation of the images of the brain and its various parts in the horizontal, vertical or transverse plane. Producing a CD-ROM of this type is very expensive both in cash terms and the amount of work required. The TLTP initiative recognized that collaboration between institutions would be necessary in the future. We believe that pooling resources and sharing experience will be the best way to provide high quality, educationally effective multimedia teaching.

References

1. Open University, *The Human Brain*. Video SD206/VC3. Open University (1993).
2. The Anatomy Project. *Neuroanatomy, 1, 2 & 3* (CD-ROM or Videodisk). The Anatomy Project (1995).
3. Dewhurst, D. and Meehan, A. *Nerve Physiology*. Sheffield BioScience Programs (1989).
4. Davies, P. Biodiversity Consortium. In: *Teaching and Learning Technology Science Case Studies*, 7–12, TLTP (1995).
5. Robinson, D. (ed.), *Neurobiology*. Open University (1992).

6. Hutchings, G. A., Hall, W. and Davis, H. C., Hypermedia link services: accessing networked learning resources. In: Advisory Group on Computer Graphics, *Multimedia in Higher Education: Portability and Networking*, Workshop Report, Technical Report Series No. 24 (1993).
7. Laurillard, D. (1993) *Rethinking University Teaching: A Framework for the Effective Use of Educational Technology*. Routledge.
8. Singer, R. A., Usability study of the Scholars' Desktop. Report No. 1. Open University (1994). (Copies supplied by author on request.)

Acknowledgements

We would like to stress that, as Academic Editors of the project, we are only two members of a large production team working on *The Multimedia Brain* whose members include Geoff Austin (Software Designer); Mike Bibby (BBC Graphics Designer); Sandra Budin (BBC Production Assistant); George Ford (Consultant); Mike Gray (BBC Graphics Designer); Michele Hutchins (Prototype Unit Production Assistant/Production Consultant); Marie Jefsoutine (BBC Graphics Designer); Rissa de la Paz (BBC Producer); Dick Sharp (Science Editor); Ronnie Singer (Courseware Evaluator); Gary Tucknott (Unit Production Assistant); Nicholas Watson (BBC; Senior Producer Science and Technology); Huw Williams (BBC Multimedia Project Coordinator); and Darren Wycherley (BBC Assistant Producer). Geoff Austin, Mike Bibby, Sandra Budin, Mike Gray and Nicholas Watson worked also on the production of the *Human Brain* video, along with Paul Chew (BBC Graphics Designer), Michael Lawrence (specialist microscopy) and Lawrence Ward (visual effects) and members of the Biology Department at the Open University. We would also like to thank Alison Taylor for her work on setting up the brain database, generating the images for the *Human Brain* and acting as Assistant Producer of the video.

The software for the Scholar's Desktop is produced by the IBIS Unit at Nottingham University and we would like to thank the Director, Peter Davies, plus Bourne Robinson (Head of the development team) and Andy Hughes (software designer).

The *Human Brain* video project was part funded by Merck, Sharpe and Dohme Ltd and by Glaxo Holdings PLC and co-produced with Encyclopedia Britannica. *The Multimedia Brain* project is being funded by a grant from the Media Development Sub-Committee of the Open University.